

A Research Note

Effect of Post-Cooking Storage Conditions on Shear-Force Values of Beef Steaks

J.D. CROUSE and M. KOOHMARAIE

ABSTRACT

One hundred twenty beef rib steaks were used to determine the effects of post-cooking storage for 2 or 4 hr at room temperature (22°C) or 4 or 24 hr at refrigerated temperature (2°C) on shear-force values of 1.3-cm cores. Steaks were cooked on an electric broiler to 40°C, turned over, cooked to 70°C and subjected to treatments. Neither time of storage nor temperature of storage affected appreciably shear-force values or variation of shear-force values within treatments. Valid shear-force values were obtained regardless of post-cooking storage conditions.

INTRODUCTION

BRATZLER (1954) developed the shear-force measurement to objectively characterize tenderness of meat, and reported that the temperature of the meat ranging from hot to warm did not affect shear-force values. Others have allowed meat to remain hot (Boccard et al., 1979), to cool to room temperature (Cross et al., 1979; Francis et al., 1981) or to chill under refrigeration (Crouse et al., 1985; Koohmaraie et al., 1989) before coring and shearing. The AMSA (1978) recommends that cooked meat should be cooled to 20°C before shearing. Williams et al., (1983) observed that cores obtained from Longissimus muscle beef roasts 2 hr post-cooking had lower shear-force values than cores obtained 24, 48, 72 or 168 hr post-cooking. The effect of storage time and temperature on shear-force values of cooked beef steaks has not been adequately evaluated. The objective of our work was to determine whether holding temperature and length of time of storage affected shear-force values of cooked beef steaks.

MATERIALS & METHODS

ONE HUNDRED TWENTY rib steaks from 30 carcasses were used for evaluation of storage time and temperature effects on shear-force requirements. The steaks were obtained from a study of crossbred steers that were about 14 to 16 mo of age (Charolais, Gelbveih, Pinzgauer, Shorthorn, Galloway, Longhorn, Nellore, Piedmontese, Salers, Hereford or Angus sires bred to Hereford or Angus dams). Cattle had been fed a corn-corn silage finishing diet for about 120 days before slaughter. Carcasses were aged 24 hr and ribbed by USDA (1976) procedures. The rib section from the right side (5th through 7th rib) was boned, 2.5-cm thick steaks were cut, vacuum packaged and frozen on the fourth day postmortem.

Steaks were prepared according to AMSA (1978) guidelines. Frozen steaks were tempered 24 hr at 2 to 5°C, then broiled on a Faberware "Open-Hearth" broiler, Model No. 450N. Internal temperature was monitored with iron constantan wire thermocouples attached to a Honeywell potentiometer, Model No. 112. Steaks were turned over at 40°C, removed from the broiler at 70°C, and stored in ventilated polyethylene bags during subsequent storage.

One steak per carcass was subjected to each of the following treatments: 2 hr (2 RM) or 4 hr (4 RM) at room temperature (22°C) and 4 hr (4 RF) or 24 hr (24 RF) at refrigerator temperature (2°C). Storage times before shearing were equal to or within 26 min of the time

specified for the method (Table 1). Prior to coring, a thermocouple was inserted to measure internal temperature. Steaks stored for 2 hr at room temperature had not completely attained room temperature, nor had those stored for 4 hr in the refrigerator attained refrigerator temperature.

Six 1.3-cm cores were removed per steak, parallel to the muscle fibers, for shearing perpendicular to the muscle fibers with a Warner-Bratzler shear blade attached to an Instron 1132/Microcon II Universal Testing Instrument operating at 5 cm/min. Cores were maintained at treatment temperatures and sheared within 0.5 hr of coring.

Data were analyzed by least-squares procedures (SAS, 1982). The model included method of storage, location in the carcass where steaks were obtained, and interaction. Correlations of shear force with temperature of meat at coring time were also computed over all methods of storage (treatments) or pooled within methods of storage. Linear and quadratic regressions of shear force on core temperature were computed.

RESULTS & DISCUSSION

COOKED MEAT TEMPERATURES declined with time of storage and were lower when stored under refrigeration compared with those stored at room temperature (Table 1). The meat ranged from 5 through 29°C at the time of coring. Changes in temperature from time of coring to time of shearing were not obtained.

Variation in shear force was not affected by location of steak or the location by treatment interaction. Shear-force values ranged from 5.22 through 5.60 kg for storage treatments, and were not different ($P < 0.59$). The overall or residual correlations between shear force and core temperature were $r = -0.10$ ($P < 0.28$) or $r = 0.19$ ($P < 0.04$), respectively. As treatment means for core temperature increased, shear force decreased. However, within treatments, as the temperature of the meat increased, shear force increased. Linear and quadratic regression of shear force on core temperature were not significant ($P < 0.54$). Our results were not in agreement with Williams et al. (1983), who observed in cooked beef roasts from the Longissimus muscle, lower shear-force values at 2 hr post-cooking as compared to longer storage periods.

Standard deviations (Table 1) indicate variation among steaks within treatments was also similar among all treatments. Bratzler (1954) and Williams et al. (1983) both considered that more homogeneous shear-force values would be obtained from meat stored 24 hr. Doty (1954) considered that more uniform cores could be obtained from chilled meat than warm meat, and the uniform cores would reduce shear variability.

Based on research reported here, length of time of storage

—Continued on page 860

Table 1—Storage time, internal meat temperature and shear force values by storage treatment

Storage method ^a	Storage time, hr	Meat temp, °C	Shear force, kg	
			\bar{x}^b	SD
2 RM	2.2	29	5.22	1.23
4 RM	4.2	24	5.27	1.19
4 RF	4.2	14	5.53	1.39
24 RF	24.1	5	5.60	1.29

^a Room temperature (RM) or Refrigerator temperature (RF).

^b Probability of means being different was $P < 0.59$.

Authors Crouse and Koohmaraie are with the Roman L. Hruska U.S. Meat Animal Research Center, ARS, USDA, P.O. Box 166, Clay Center, NE 68933.

EFFECT OF MEAT POST-COOKING STORAGE. . . From page 858

after 2 hr post-cooking or ambient temperature storage of beef steaks has no significant effect on shear-force values of cores.

REFERENCES

- AMSA. 1978. Guidelines for cookery and sensory evaluation of meat. American Meat Science Association and the National Live Stock and Meat Board.
- Boccard, R.L., Naude, R.T., Cronje, D.E. Smit, M.C. Venter, H.J., and Rossouw, E.J. 1979. The influence of age, sex and breed of cattle on their muscle characteristics. *Meat Sci.* 3(4): 261.
- Bratzler, L.J. 1954. On using the Warner-Bratzler shear. *Proc. 7th Annual Recip. Meat Conf.*, Chicago, IL. p. 154.
- Cross, H.R., Stanfield, M.S., Elder, R.S., and Smith, G.C. 1979. A comparison of roasting versus broiling on the sensory characteristics of beef longissimus steaks. *J. Food Sci.* 44(1): 310.
- Crouse, J.D., Cross, H.R., and Seideman, S.C. 1985. Effects of sex condition, genotype, diet and electrical stimulation on the collagen content and palatability of two bovine muscles. *J. Anim. Sci.* 60: 1228.
- Doty, D.M. 1954. Comments. In On using the Warner-Bratzler shear. *Proc. 7th Annual Recip. Meat Conf.* Chicago, IL. p. 154.
- Francis, S.J., Allen, D.M., Kastner, C.L., and de Felicio, P.E. 1981. The effect of coring method on beef longissimus muscle shear force values. *J. Anim. Sci.* 52(6): 1294.
- Koohmaraie, M., Whipple, G., and Crouse, J.D. 1989. Acceleration of post-mortem tenderization in lamb and Brahman-cross beef carcasses through infusion of calcium chloride. *J. Anim. Sci.* (In press).
- SAS. 1982. *SAS User's Guide: Statistics*, p.101. Statistical Analysis System Institute, Inc., Cary, NC.
- USDA. 1976. Official United States standards for grades of carcass beef. Title 7, Ch. 28, Pt. 2853, Section 102-107. Code of Federal Regulations, U.S. Department of Agriculture, Washington, DC.
- Williams, J.C., Field, R.A., and Riley, M.L. 1983. Influence of storage times after cooking on Warner-Bratzler shear values of beef roasts. *J. Fd. Sci.* 48: 309.

Ms received 1/8/90; accepted 1/28/90.

The authors acknowledge Ms. Kay Theer for her contributions to the design of research, execution of work and analysis of data.

Mention of trade names, proprietary products or specific equipment does not constitute a guarantee or warranty of the product by the USDA and does not imply its approval to the exclusion of other products that may also be suitable.
